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NOTICES OF The Aeronautical Society.

A General Meeting of the Society will take place in December (the exact date will be notified hereafter), when, in addition to the reading of several interesting papers, it is hoped there will be an exhibition of the Cinematograph, showing the action of flying birds, the photographs for which are now being specially procured for the Society.

Members and others are informed that the Hon. Secretary has only a few complete sets left of the Reports of the Society (1866-1893). *These are sold to the public at ONE GUINEA the set of 21 vols., or to members, at half-price* (10s. 6d).

B. BADEN-POWELL, CAPT.,
Hon. Sec.

Recent Advancement in Aerodynamics.

Mr. Lawrence Hargrave has sent us the results of some recent experiments of his, of which we hope shortly to hear fuller details, as the subject is one of the greatest interest and importance. These experiments tend to show—

1st. That the profile of a soaring bird's wing, and pieces of metal of a somewhat similar curve, generate vortices on their concave surfaces when the chord of the curve makes a negative angle with the direction of the wind.

2nd. That all the concave surface is in contact with air moving *towards* the mean direction of the wind.

3rd. That the mean pressure on the concave surface is higher than that on the convex side.

4th. That the chord of the curved metal may make a negative angle of ten degrees with the direction of the wind, and still have a higher pressure on the concave side than on the convex.

Hence Mr. Hargrave infers:—

"That gravity can be entirely counteracted by a volume of disturbed air moving in a horizontal direction; and that flying machines of great weight can be held suspended by a horizontal wind, and rise vertically without the expenditure of any contained motor force." We would point out, however, that in order to cause this upward force to act *continuously*, either a horizontal forward thrust must be applied, or the wing be held in a fixed position, so as not to be carried back by the wind force

This subject has also been under investigation by Capt. Baden-Powell, who used an instrument consisting of an upright cylinder in the top of which is placed a fan blower to draw a current of air upwards. Smoke is introduced at the bottom so that the course of the currents may be visible. Two windows, one for admitting a strong light, the other for observation, are cut in the cylinder, and opposite the second one, inside the funnel, is a holder for carrying the model to be experimented upon, which can be fixed at any desired angle. By means of this instrument, this eddying action of the current on a concave surface is very distinctly seen, though the pressure cannot thus be determined. It will be interesting to hear with what kind of apparatus Mr. Hargrave has been experimenting.

MAJOR MOORE'S MODEL FLYING MACHINE.

Report on Experiments made by Major R. F. Moore (late R.E.),

To ascertain the power and means necessary for Flight with Wings.

INTRODUCTION.

The two chief methods proposed by inventors for obtaining aerial flight are by means of aeroplanes or aerocurves, driven by screw propellers, and by wings worked as in nature.

Which of these designs will practically be best it is difficult to say. It can only be by actually trying the two methods that their merits can be compared.

It may be that wings are the best, as they move a larger weight of air with less velocity than a screw propeller. The slip may on this account be less.

With a view to throw some light as to how nature solves the problem of flight with wings the following investigation has been made with a Flying Fox as a type.

The practical experiments made from the results are based on the supposition that by imitating Nature as closely as possible, both as to structure and action similar effect may be anticipated. In other words, an artificial Flying Fox should fly as well as a natural one, with an allowance made for defects in clumsiness of manufacture.

The want of a sufficiently light motor for its power has prevented these experiments being brought to a finality.

I.—INVESTIGATION OF A FLYING FOX.

In Rangoon, Calcutta, and some other parts of India flocks of Flying Foxes may be seen, towards sunset, travelling high overhead to their feeding grounds. They have a very uniform action with their wings, and their motion can be detected by the unaided eye.

The photograph (see Fig 1) is of a stuffed specimen sent to the writer from Madras.

According to Mr. M. P. Harting, as shown in the Aeronautical Society's Report for 1870, the Pteropus Edulis, as it is called, weighs over 3 lbs. avoirdupois, and measures 47¼ ins. from tip to tip of wing. The area of the wing is 126.325 sq. ins., and length 20.551 ins.

Mr. Harting says that the weight he quotes may be wrong, as it was taken from a dead specimen.

From measurements of a similar sized Flying Fox when alive it was found to be about 2 lbs. instead of 3 lbs.

This difference in weight alters the constants as given in Mr. Harting's formulæ (see page 68 to 70 of the Society's Report for 1870).

FIG. 1.—FLYING FOX (under side).

If w, a, and l represent respectively the weight in grammes, the area in square centimetres, and the length of the wing in centimetres, then we have for the Pteropus Edulis in the formulæ where

$$a=(n\sqrt[3]{w})^3$$

$$l=r\sqrt[3]{w}=m\sqrt{a}$$

$n=2{\cdot}95$ instead of $2{\cdot}55$

$r=5{\cdot}27$,, 468

$m=1{\cdot}83$ as before.

(See Appendix A.)

By Appendix B, using the corrected formulæ, we find that for a Fox weighing 200 lbs. we require wings $7\frac{3}{4}$ ft. long each, and an area of $18\frac{1}{4}$ sq. ft. each. Wings this size should therefore suit for a Bat or Fox equal in weight to a man taken at about 14 st.

It is possible to test the velocity of flight of these animals by attaching a thread to their hind claws, and noting the time in which they run out a certain length.

It has been found by this means that a Fox that makes 3 strokes per second with its wings travels 21 ft. per second, so that for each stroke up and down of its wings it travels 7 ft. This rate of progress is some $14\frac{1}{3}$ miles per hour. This is slower than what the Fox would do if free and in full flight. The string dragging behind it probably checked its momentum.

These Foxes hang all day from the branches of high trees by their hind claws, with their heads downwards. It is only in the evening and at night they fly any distance, unless disturbed. When they want to fly they drop downwards and launch themselves off on the air.

When allowed to go free on the ground they generally make for the nearest tree or high place to climb up before flying off, though they have been known to fly from the ground direct. To do this they first distend and inflate their wings by getting air underneath, and then take off apparently with considerable extra exertion.

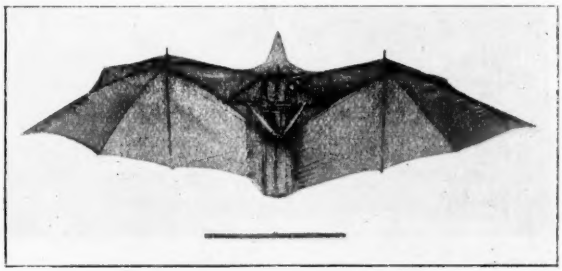
These Foxes, besides their own weight, can fly with their young clinging to them. A Fox weighing 18 ozs. carried a young Fox weighing 4 ozs., or two-ninths of its own weight. In addition it carried a string and strap weighing $\frac{1}{4}$ oz.

Their bodies are covered with hair, and they have a head like a Fox.

The wings are formed of bones, covered with a membrane. The bones resemble those of a human arm and hand, and are similarly named, viz., the main arm, or humerus, the fore-arm, or radius, and the digits, composed of 4 fingers and a thumb. (See Fig. 2.)

The wing is constructed so as to be very stiff along the front edge, and very pliant at the rear edge. There is a ball socket at the shoulder joint, but not at the elbow. This shows that the wing is rigid in itself when distended, and that the socket at the shoulder is the only hinge where movement takes place for flapping. Any alteration in the wing during flight is due to its flexibility. The joints at the elbow and wrist are called into play when the animal requires to fold its wings. This it does when it comes to rest, such as when hooking itself on to a tree.

When the wing is fully opened out the main-arm and fore-arm form an angle of 110 degs.



Model Flying Fox.

The joint at the elbow is raised above a line from the shoulder to the wrist by 1-18th of the length, so that the underside of the wing is concave.

The fourth finger is nearly parallel in plan with the centre line of the body. In line with it, extending to the front, is the thumb. This acts as a strut to a strong sinue which stretches from the shoulder to the end nearly of the first finger. This sinue forms a sharp cutting edge for the membrane which covers the wing, and it also distends the wing by its attachment to the first finger.

The second and third fingers divide the space unequally between the first and fourth fingers, and assist with them to spread the membrane of the wing.

The legs are in rear of the body. They are straightened when flying, and distend the membrane for that part to form a kind of tail.

When looking at a Fox from below, as it flies in the air, the tips of the wings cannot be seen by the naked eye. The wings take the

shape of two squares, with two triangles constructed on their outer sides, as shown in Fig. 3. This sows that the tips of the wings and posterior edges are turned up with the pressure of the air acting under the wings.

The area of one wing, as mentioned before, is 126.325 sq. ins. for a Fox weighing 2 lbs. Of this the membrane of the tip to the line of the first joints measures 26 sq. ins., or nearly one-fifth of the whole area. The membrane between the lines of the first and second joints measures 28.9 sq. ins. These two portions added together measure 54.9 sq. ins., which is approximately three-sevenths of the whole area.

Taking the weight of the Fox as 2 lbs., we find this load is flown with a spread of some 250 sq. ins. in the two wings. This is equivalent to 1.152 lbs. per sq. foot.

If the area of the body is taken into consideration in the spread, the load would be about 14 ozs. per square foot.

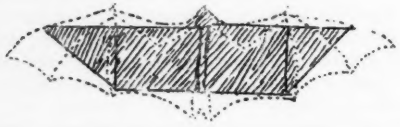


FIG. 3.

The membrane at the tail, which is distended by the legs, is apparently used for guiding and checking the motion of translation when necessary.

The aeroplane of the Fox when spread may be considered for the portions, (*a*) that act as a support on the air, (*b*) for driving, and (*c*) for guiding or checking the motion.

The Fox when flying makes 120 to 180 strokes per minute with its wings.

The amplitude, judged by the eye, does not exceed 45 degs. when in full career.

The wings are worked by the breast muscles, to which they are attached by ligaments.

The pectoral muscles is the name given to the largest pair of the breast muscles, and are the ones that pull the wings down. The body is suspended between the wings by these muscles when on the air, and by their action cause the body to oscillate in a vertical direction to reciprocate with the motion of the wings to produce flight.

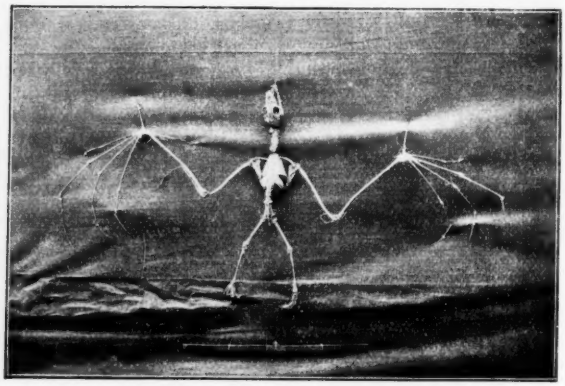


FIG 2.—SKELETON OF FLYING FOX.

The pectoral muscles take the strain of the leverage of the wings when on the air, and it is believed are actuated by nerves in connection with the brain.

The pectoral muscles are attached to the humerus at a place about one-sixth the length of the humerus out from the shoulder.

The way in which the breast muscles act in the case of birds to work the wing is very clearly described in Mr. F. W. Headley's book on "The Structure and Life of Birds."

How muscles can be made to contract by the action of an electric current, and so perform work, is described in Dr. J. Rosenthall's book on "Muscles and Nerves."

II.—ARTIFICIAL IMITATIONS OF NATURE.

Since commencing experiments, in imitation of the Flying Fox, with wings, it has been noticed that Professor Pettigrew, in his book on "Animal Locomotion," etc., page 111, says:

"In the aerial machine, as far as yet devised, there is no sympathy between the weight to be elevated and the lifting power, whilst in natural flight the wings and the weight of the flying creature act in concert and reciprocate, the wings elevating the body the one instant, the body by its fall elevating the wings the next. . . ."

This statement of Professor Pettigrew is in accordance with the idea on which the following experiments have been made. His difficulty appears to have been to apply his theory practically.

Again, Professor Pettigrew says further down in his book: "Weight, assisted by the elastic ligaments or springs which recover all wings in flexion, is to be regarded as the mechanical expedient resorted to by nature in supplementing the efforts of all flying things."

The elastic ligaments he speaks of as supplementing Nature are found by these experiments to take the whole strain of the wings, and also quicken the action of the power put into them by their resilience.

This quick action is not due to "some mysterious chemical action which is propagated more readily in the muscles of birds than in those of any other animal," as stated by Marey in his book on "Animal Mechanism," page 215. The following experiments show that it is due to the reaction of the muscles in consequence of their elasticity or resilience, as stated above. In Marey's book on "Movement," published since in 1895, he, however, at page 162-164, foot note, speaks of this rebound action.

This action of the muscles can be imitated by using springs in their place.

If we hang a weight of 20 lbs. on a spring balance the spiral spring inside (which in Salter's balance for weights up to 75 lbs. is

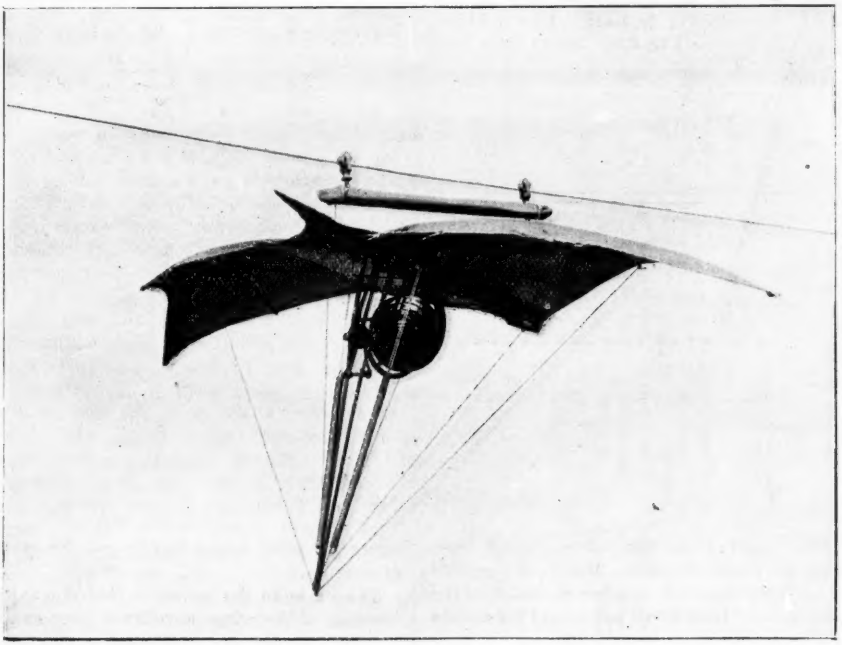


FIG. 4.—CLOCKWORK MODEL.

6 ins. long) is stretched $\frac{13}{16}$ in. If we jog it by adding an extra pressure to the load, and then quickly remove the added load, the spring with its weight will oscillate vertically some 240 times per minute. This is what happens in the case of the pectoral muscle when working, only the added load or pressure is added each stroke for continuous action.

The number of oscillations the spring will make in a given time depends on the amount of weight put on it, and the length of the spring.

If the weight put on the spring is increased

the number of oscillations will be reduced: thus, if we double the load to 40 lbs., the oscillations become 180 per minute instead of 240, which is a reduction of some 25 per cent.

If we double the length of the spring, instead of doubling the load on it, the oscillations are 140 per minute instead of 240, which is a reduction of some 40 per cent.

It may be seen from this that springs vary in the number of natural oscillations they make when actuated in some ratio depending on the amount of load put on them, and their length.

The pectoral muscles of different species of birds vary in their thickness, weight, and length for the same reason. Mr. Hargrave shows that the pectoral muscles vary in relation to the weight of the body in bats and birds from 1 in 15.5 to 1 in 6.08. Some birds have a more rapid action than others, though their weight is much the same. Marey, at page 228 of his book, shows the number of strokes of the wing to vary from 3 to 9 per second for certain birds, as given in his list. A sparrow he shows makes as many as 13 strokes per second.

The power to be put into the springs, when strained, to actuate them is the added load for each stroke, acting through a certain space in a certain time. Its amount depends on the stiffness of the spring concerned, so that if any particular length of oscillation is required, the load added each stroke or power must be great enough to effect it.

By practically ascertaining what springs would replace the pectoral muscles in any particular flying animal, it is possible to ascertain what mechanical power is required to work its wings with the number of strokes and amplitude as in nature.

To investigate this models have been made in imitation of the Flying Fox, with artificial wings. Natural wings are difficult to fix. (See Frontispiece and Fig. 4.) The way artificial wings and machines are constructed is described in my patent specification, No. 6, 1895.

III.—STRAINS AND STRESSES.

The wing is a lever of the third order, where the power comes between the fulcrum and the load. The only difference is that in the case of the wing, the lever is turned over so that the strains are reversed (see Figs. 5 & 6. "A" is the Fulcrum, $\frac{S}{2}$ the strain keeping the wing down, $\frac{p}{2}$ the pressure of air under the wing acting upwards at the centre of pressure.

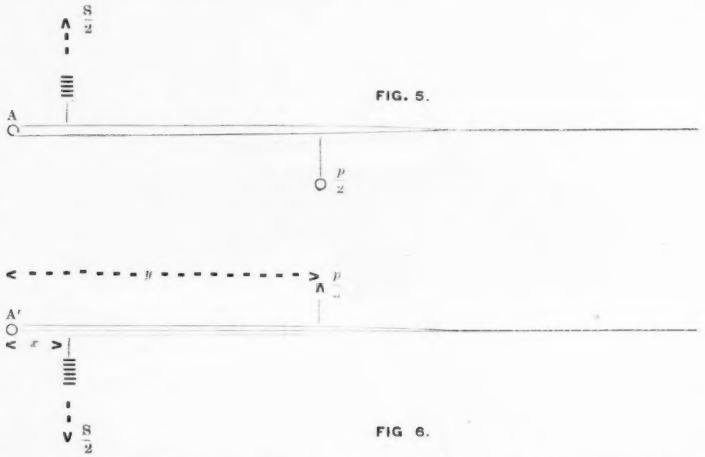


FIG. 5.

FIG 6.

The strain on the springs is that due to the leverage of the wings as when resting on the air. Thus, if $\frac{p}{2}$, $\frac{p'}{2}$ represent the pressures of the air at the centres of pressure of the wings at say distance "y" from the shoulder joints, and $\frac{S}{2}$, $\frac{S'}{2}$ are the strains on the springs at distance "x" out, then taking moments (see Fig. 6), we have

$$\frac{S}{2}x = \frac{p}{2}y,$$

$$\therefore S = p\frac{y}{x} \quad \ldots\ldots \text{(i.)}$$

Now $p = w$, the total weight of the machine,

$$\therefore S = \frac{y}{x}w \quad \ldots\ldots \text{(ii.)}$$

This is approximately the strain the springs have to sustain when the body and wings are resting on the air in flight.

Strong enough springs must be selected for any particular machine that are capable of taking this strain without injury to the elasticity.

They must at the same time, as said before, be capable of giving the right number of oscillations per minute when actuated under this strain and the right amplitude.

In the case of the Flying Fox, 120 to 180 strokes per minute for the wings have been counted. The number made by different species of flying animals varies considerably as already stated.

It is difficult to say what the amplitude of the wing should be; this also varies considerably, even in the same flight. It is taken that it should not be less than 30 degs.

With regard to the size of the wings: the smaller, or rather shorter, they can be made for any particular load the better, as this reduces the leverage; on the other hand the smaller they are, the greater must be the horizontal driving power to obtain the increased sustaining pressure per square foot of area of wing.

An ordinary Flying Fox does not fly much more than 1 lb. per square foot of wing area. From the table given in Mr. Chanute's book (pages 46, 47), it may be seen that for different species of flying animals, the amount varies from $\frac{1}{8}$ lb. to $2\frac{1}{4}$ lbs. per square foot.

For the greater weight supported, the wings are narrow and long instead of short and stumpy as in the case of the Flying Fox, though the area of the spread may be the same. The greater length of wing for the same number of flaps causes the tip to travel through a longer space in the same time. The tip of a wing twice as long as another would have twice the velocity. Again the pressure on the air caused by the fanning of the tip varies with the square of the velocity, so that in the case above, if one wing is, say, 2 ft. long and the other is 4ft. the velocities are as 2 to 4, and the pressures on the air are as 4 to 16.

The longer wing therefore might be expected to fly four times the load per square foot of its spread than the shorter one, if no account is taken to the extra resistance of the air.

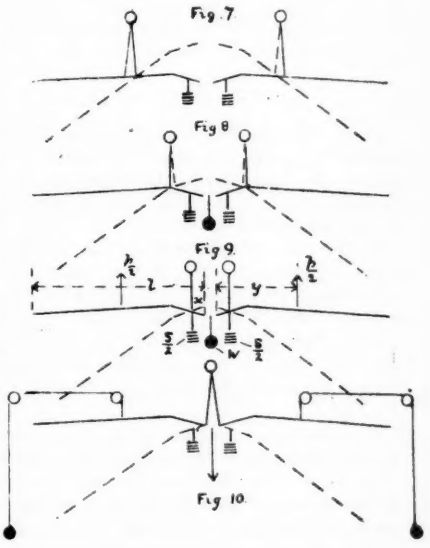
Mr. Maxim has flown in his machine with a load of 2 lbs. per square foot. Mr. Phillips' machine rose with $2\frac{1}{2}$ lbs. per square foot. Lilienthal soared with 1.45 lbs. per square foot. From this it is evident that it is possible to arrange some mechanical means that will fly with a load which is up to that flown in nature, namely, $2\frac{1}{4}$ lbs. It is chiefly a question of obtaining the best driving power for the weight.

IV.—PRACTICAL METHODS FOR TESTING THE STRAINS AND STRESSES.

To test the strains and stresses under which the wings of the machine work as described in the patent specification, it is suspended in different ways, preparatory for free flight.

1. At the centres of pressure of the wings, when the body rises and falls each stroke (see Fig. 7).

2. At the apexes of the wings, with added weights (see Fig. 8). The added weights are the equivalent for the leverage on the air, and cause the correct strain to the springs.



3. At the point of attachment of the springs with added weights (see Fig 9).

4. At the body with balanced weights for the pressure of the air at the centres of pressure (see Fig. 10).

5. At intermediate places between the hinge and apexes of the wings with calculated added weights.

6. With the position of the attachment of the springs to the main arm also varied.

In cases ii., iiii., and v., weights have to be added to that of the body to strain the springs and compensate for the effect of the

pressure of the air under the wings as when flying.

The machine being suspended, cannot get its horizontal momentum to create the supporting pressure as in flight, so calculated weights are added to make up for this.

To find the weight to be added to strain the springs correctly, we know that the sustaining pressure at the centres of pressure of the wings must be equal to the whole weight of the machine, so that if $\frac{p}{2}$, $\frac{p'}{2}$ each equal these pressures, if w equals the weight of the machine, and if w_1 is the weight to be added as the equivalent for the pressure of the air, we can find the amount by taking moments about the point of support when (Fig. 9),

$$w_1 x = 2\frac{p}{2}(y-x),$$

$$\therefore w_1 = \frac{y-x}{x} p \quad \ldots\ldots \text{(iii.)}$$

$$= \frac{y-x}{x} w.$$

From this equation it may be seen that the smaller x is, the larger is the weight to be added. In other words, the nearer the point of suspension is to the hinge, the greater must be the weight to be added.

If the point of suspension is at the hinge itself, as shown in Fig. 10, the weight to be added must be infinite; the body would then be fixed, and all the motion would be in the wings. Balanced weights have to be used in this latter case as the equivalent to the pressure of the air at the centres of pressure (see Fig. 10).

If x equalled y, then the point of suspension would be at the centre of pressure as shown (Fig. 7), and the maximum motion would be in the body. In this case no extra weight for strain would have to be added.

When making experiments with springs fixed at different distances out, the best result was obtained for wings 2 ft. long when the springs were fixed in the same position as the pectoral muscles in nature. This is about 1-6th the length of the humerus out, or 1-36th the length of the wing from the shoulder joint in the case of the Flying Fox.

This point where the pectoral muscle is attached is also the best point for suspension, and is assumed to be the point of non-oscillation in the wing in flight for wings up to 2 ft.

As the wings increase in length the springs must be brought closer to the shoulder joint than 1-36th the length of the wing, or the lift each stroke would become too great to admit of sufficient amplitude and to give the right number of strokes in the time.

The springs, with their load, act under the influence of gravity, so that the height of the lift must be regulated for the quickness of action required. Thus by the formula in Dynamics we have

$$h = \frac{1}{2} g t^2,$$

where in this case $t = \frac{1}{2} \times \frac{60}{144}$ seconds

$= \cdot 2$ of a second.

Marey, in his book (page 223), shows that the time of descent of the wing is greater than the time of ascent as 5 is to 3, approximately, so that the time of descent in this case is taken at $\cdot 3$ of a second instead of $\cdot 2$,

therefore $h = \frac{1}{2} \times 32 \cdot 2 \times \cdot 3^2$

$= 16 \cdot 1 \times \cdot 09 = 1 \cdot 45$ inches.

This would be the rise of the body each stroke if it were not for friction and the resistance of the air.

For an amplitude of 30 degs. the angle of rise is about 1 to 2, so the springs which are attached at the point of non-oscillation must not be fixed out on the humerus at a distance exceeding twice the rise, or in this case twice 1.45 ins. from the shoulder joint for a rate of 144 strokes per minute. (See Fig. 9.)

On the other hand the springs must be fixed as far out as admissible for the number of strokes required as friction is increased due to the extra stresses from the leverage of the wing.

Knowing approximately the position for fixing the springs for any particular machine, we must now select those that will stand the strain, and at the same time give the right amplitude when actuated, and the right number of oscillations.

The work expended for flight is the amount necessary to actuate the springs, and so cause the body with its added weight for strain to oscillate up and down in a vertical direction, and so give the necessary amount of amplitude to the wings, and the necessary number of strokes per minute.

For an amplitude of 30 degs. the amount the body has to be lifted equals $\frac{x}{2}$ each stroke, or $\frac{l}{36}$, where "x" as before equals the distance out of the point of non-oscillation from the shoulder joint of the wing, and "l" equals the length of the wing.

The number of strokes is taken at 144 per

minute, being the approximate average number for a Flying Fox.

The centre of pressure of the air under the wing is taken as acting at $\frac{4}{9}\,l$, the length of the wing from the shoulder joint, as shown in Mr. Chanute's book, page 41.

If w_1 is the added weight for strain as shown in equation iii., page 23, then

$$w_1=\frac{y-x}{x}\,p$$

where $y=\frac{4}{9}\,l$; $x=\frac{l}{36}$, $p=w$,

therefore $w_1=\frac{\frac{4}{9}\,l-\frac{1}{36}\,l}{\frac{1}{36}\,l}\times w=15\,w\,l$ . . . . (iv.)

As the weight of the body has also to be lifted, the total weight to be raised each stroke

$$=15\,wl+w$$
$$=(15\,l+1)\,w \quad \ldots\ldots\ldots \text{(v.)}$$

The work to be done per minute

$$=(15\,l+1)\,w\left(\tfrac{1}{2}\times\frac{l}{36}\right)144$$
$$=(15\,l+1)\,2\,wl \quad \ldots\ldots\ldots \text{(vi.)}$$

For a Flying Fox with 2′ wings, and weighing 2 lbs., we have for flight

$$\text{work}=2\times2\times2\,(15\times2+1)$$
$$=8\times32=248 \text{ ft. lbs.}$$

This is at the rate of 1 H.P. for 264 lbs.

Again, if we take the size of a Fox as calculated in Appendix B, we have

$$w=200 \text{ lbs}, \quad l=7{\cdot}75',$$

then by equation vi. we have for flight

$$\text{work}=(15\times7{\cdot}75+1)\,2\times200\times7{\cdot}75$$
$$=363470 \text{ ft. lbs.}$$

This is at the rate of 1 H.P. for 18 lbs.

This difference of rate of load per horse power between a Flying Fox weighing 2 lbs.

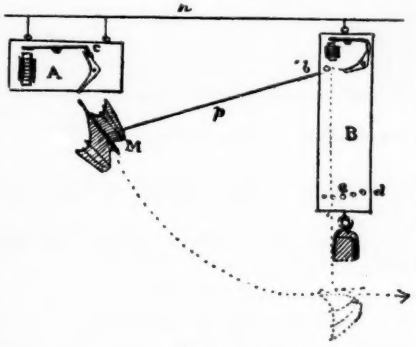


FIG. 11.

and one weighing 200 lbs. may be accepted as due to the extra velocity of translation necessary for the latter to obtain a greater supporting pressure on the air. In the former case the pressure is under 1 lb. per square foot and in the latter is $5\frac{1}{2}$ lbs., which is an extreme case.

Again it may be seen by a special calculation, (Appendix G), that for a load of 125 lbs. with a pressure of $2\frac{1}{2}$ lbs. per square foot on the wing area, 1 horse power would fly over 100 lbs.

The power necessary for flight for heavier loads per square foot of wing area increases on a sliding scale. It is well to keep the total load down for any one machine as much as possible. Each man should have his own machine for this reason.

After having adjusted a machine for the correct strain on the springs as shown above it can be launched on the air in free flight.

For this slip catches have been used, worked with electric currents (see Fig 11).

These slip catches are hung from an overhead wire, and are arranged to throw off the machine at different angles of inclination to the ground as required for experiment, and with different amounts of momentum by altering the drop.

It is found that the machines go off best on the air when the inclination of the body is $\frac{1}{8}$ to the horizon.

V.—EXPERIMENTS WITH MODELS TO ASCERTAIN THE POWER REQUIRED FOR FLIGHT.

The first model has wings driven by a clock spring. When the spring is released the model runs along the wire from which it is suspended. This experiment shows that the wings, when flapped, give a horizontal driving force. The best effect is found to be when the body is inclined upwards $\frac{1}{8}$ to the horizon (see Fig. 4).

From calculations for this model the power necessary for flight is at the rate of 1 h.p. for 162 lbs. (See Appendix C.)

With a clock spring, as used in the first model, the power could not be varied conveniently nor could it be made to work continuously. Experiments have been made since with models fitted with electro motors to work the wings. (See Fig 12.)

Electro motors are convenient in many ways for experimental purposes.

(*a*) The motor alone may be fixed in the machine, the electric current being conveyed to it by wires. This dispenses with the weight of the dynamo or electric battery for supplying the current.

(*b*) Electro motors are simple in their construction, compared with steam engines or gas engines, and can be easily interchanged.

(*c*) They are simple to put in motion or stop,

as it is only necessary to connect or disconnect the current.

It is found that a direct acting motor as fitted in the models (see Frontispiece), gives out better work efficiency than a rotatory one, as there is less friction with it. A description of it, and how it works is given in the specification patent, No. 6, of 1895.

A model, fitted with one of these motors, when fully loaded, including the storage battery weighs 3 lbs. 6 ozs. The added load for the strain on the springs is 50 lbs. The springs are fixed at $\frac{5}{8}$ in. out from the shoulder. The best results gave 144 strokes per minute with an amplitude of 17 degs. A much stronger motor is necessary for this model, as the amplitude should be at least doubled to be sufficient for free flight.

For calculation of the work required, see Appendix E, where it is shown that it would amount to 500 ft.-lbs. to fly the model. The rate of load per horse power is 226.4 lbs.

With another larger direct acting motor fitted on arms working on ball bearings, 144 strokes per minute were obtained with an amplitude of 26 degs. (see Fig. 13). The springs in this case were fixed 11-16th in. out, and strained with a dead load of 220 lbs.

From the calculations (Appendix F), it may be seen that the work done equalled 907.5 ft.-lbs. The load this would fly at 226.4 lbs. per horse power as shown above would be 6.2 lbs. The length of the wing should be 30 ins. The pressure to be maintained per square foot of area of wing= 625 lbs.

These experiments with direct acting electro motors, show that though the action may be right for flight, a lighter and more powerful kind is necessary.

It is believed that some of the gas engines as lately developed for motor cars would give the action as required within the limits of weight.

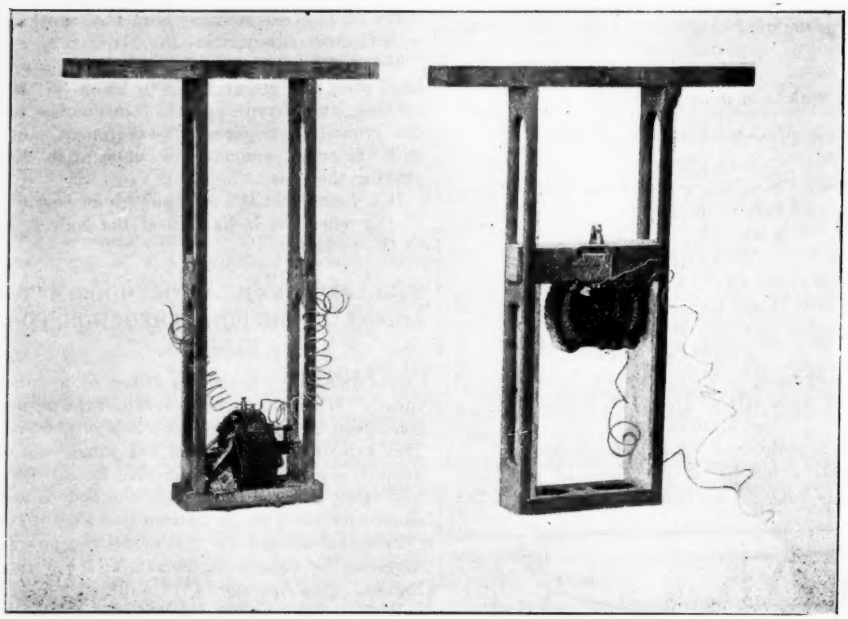


FIG. 12.—ELECTRO MOTORS MOUNTED ON FRAMING TO TAKE WINGS.

For wings fitted with a rotatory electro motor, as shown in Fig. 12, we have

weight=10·4 lbs.,

length of wing=4¼ feet (each),

distance out of point of attachment of crank rod=2·875″

do., of spring= ·75,

do., of point of non-oscillation or point of suspension=2·875, or the same as that of the crank rod.

Calculations for the following are given in Appendix D.

1. Added weight to cause strain.
2. Strain on springs.
3. Work exerted to produce 96 strokes per minute of 30 degs. amplitude.
4. Work necessary for flight.
5. Rate of load per horse power.

It may be seen from the last calculation that it requires, judging from this model, 1 horse power to fly 196.68 lbs.

A more favourable result might be expected if all the working parts were fitted with ball bearings in this model to reduce friction, also if account was taken of the work expended in fanning the air. This must be considerable, as the wings even at 96 strokes per minute drive the model forward forcibly by the breeze created.

The motor used in this model is one of Cultriss' weighing 4½ lbs. and capable of developing 1500 ft.-lbs. when running at 200 revolutions per minute. In the experiments it was running at 1900 revolutions, and gave out 720 ft.-lbs. of useful work. Nearly half its power was lost in friction.

The following is a summary of the results obtained from these experiments of the rates of load that can be flown per H.P. :

(*a*) Spring model 162 lbs. per H.P.
(*b*) 2′ wings, direct motor 226 lbs. per H.P.
(*c*) 4¼′ wings, rotatory motor 196 lbs. per H.P.

(*a*) is estimated from the strength of the driving spring (see Appendix C.).

(*b*) from the strength of the springs acting for the pectoral muscles (see Appendix E.).

(*c*) from the direct lift of the body, with the calculated strain on the side springs (see Appendix D).

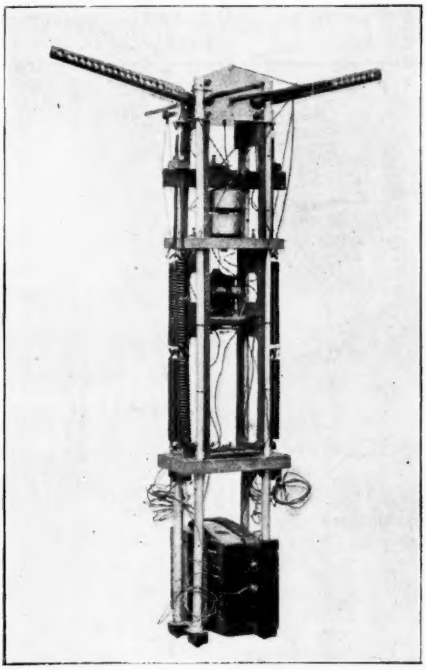


FIG. 13.—ELECTRO MOTOR WITH FRAMING TO TAKE WINGS.

VI.—CONCLUSIONS.

For a big machine capable of flying a man, it would be best to have four wings, two on each side (see Fig. 14). This would be two machines as already described joined together like in tandem. This arrangement would steady the machine in the direction of its motion. A vertical and horizontal rudder can be added if found advantageous. An inclination of about ⅛ appears to be the best for the body when in the air as far as these experiments show.

Another advantage in having four wings, or even more, instead of two, is that the leverage to the centres of pressures is reduced for the same spread, so that the strain on the wings is less, and they can be more lightly constructed. They also would not be so unwieldy.

The better horizontal stability ensured enables the centre of gravity to be raised higher in the machine as there is less tendency to dip and rock.

If the total load is taken as 250 lbs., which is 125 lbs. for the aviator, 100 for the framing and springs, 25 lbs. for the motor and fuel, we can see by Appendix F that there should be four wings, each 9 ft. 2 ins. long (see Fig. 14).

This calculated speed would be modified by the resistance of the air which increases with the square of the velocity of translation.

Chanute shows in his table of supporting areas of birds (page 47), that a speed of 66.2 miles per hour is sufficient for 2.28 lbs. per square foot, so it may be taken that a speed of some 70 miles per hour would be enough for $2\frac{1}{2}$ lbs.

In Appendix G are given calculations for the following:

(*a*) Strain on the springs.
(*b*) Equivalent weight to give strain.
(*c*) Horse power necessary for flight.

It may be seen that it will require a little over 2 horse power to fly the 250 lbs.

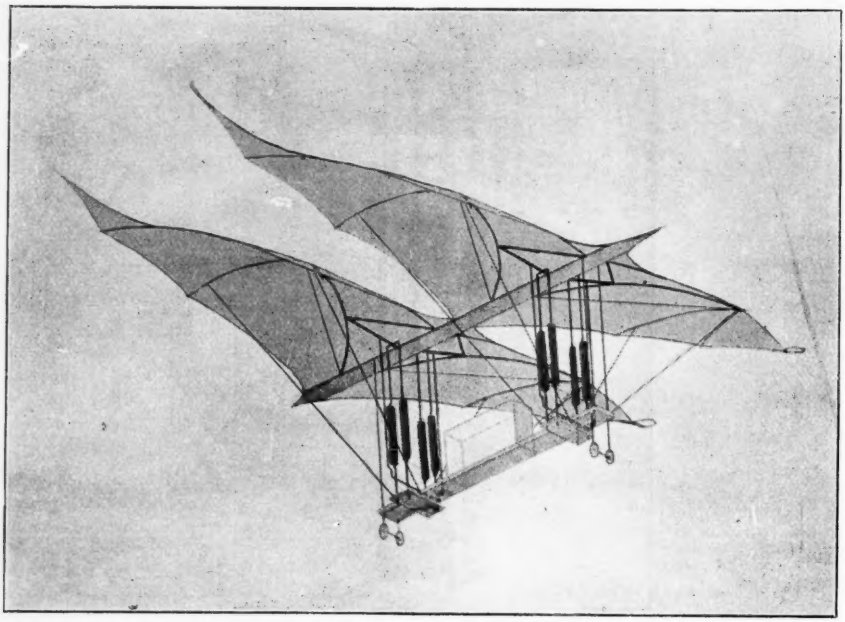


FIG. 14.—DESIGN FOR LARGE FLYING MACHINE.

The machine could be fitted with one motor to work the two pairs of wings in preference to two separate motors for each pair.

The total area of the 4 wings=100 sq. ft.
The load per square foot =$2\frac{1}{2}$ lbs.

The velocity of the tips of the wings vertically would be more than 30 times greater than for a Flying Fox which travels at over $14\frac{1}{2}$ miles per hour. It is calculated from this that the tandem machine with the 9 1-6th ft. wings should travel at 118 miles per hour.

For starting the one man machine it will be necessary to assist the wings by letting the machine run down an incline or to shoot it off with some extraneous power as a rocket or spring. If it could be placed on top of a railway carriage, it could be shot off from it when the momentum was found sufficient.

The preliminary experiments should be made without a man in the machine, when a weight might be added in his place.

In Appendix H is given a calculation for larger wings than the 9 1-6th ft. ones proposed,

so as to reduce the load per square foot of area. It may be seen that if the area was doubled so as to reduce the pressure to $1\frac{1}{4}$ lbs. per square foot the wings would have to be 12 ft. $11\frac{1}{4}$ ins. long each, which would be more unwieldy than the shorter ones, so nothing would be gained.

To summarise:

(*a*) The wings of a Flying Fox can be imitated artificially, and to an enlarged size.

(*b*) Artificial wings can be balanced with springs against the weight of the body when on the air in imitation of the pectoral muscles.

(*c*) Artificial wings, when properly constructed, generate a propulsive force when flapped.

(*d*) The pectoral muscles can be imitated by spiral springs if specially selected for the strain so as to impart the right number of strokes per minute, and amplitude when actuated with suitable power.

(*e*) Two or more pairs of wings are better than a single pair for a flying machine.

1. To give better equilibrium.
2. To economise leverage.

(*f*) Motors are being made lighter and more efficient for their weight every day so that there is every hope of a convenient and suitable one being available.

There is therefore nothing to prevent a practical flying machine being made with wings in imitation of those of a Flying Fox.

R. F. MOORE.

APPENDIX A.

To find the values of n, r, and m, as given in Mr. Harting's formulæ, page 68 of the Aeronautical Society's Report for 1870, when weight is taken at 2 lbs. instead of 3·042 lbs. for the Pteropus Edulis.

We have in French dimensions

weight $= w = 2$ lbs. $= 2 \times 453{\cdot}6$ grammes $= 907{\cdot}2$,

length of wing $= l = 20{\cdot}551'' = 20{\cdot}551 \times 2{\cdot}54$ centimetres $= 52{\cdot}197$,

area of wing $= a = 126{\cdot}325$ sq. in. $= 126\,325 \times 2{\cdot}54^2$ square centimetres $= 814{\cdot}96$ square centimetres.

(i.) $n = \dfrac{\sqrt{a}}{\sqrt[3]{a}} = \dfrac{\sqrt{814{\cdot}96}}{\sqrt[3]{907{\cdot}2}}$

$= 2{\cdot}948 = \underline{\underline{2{\cdot}95}}$ say instead of 2·55.

(ii.) $r = \dfrac{l}{\sqrt[3]{w}} = \dfrac{20{\cdot}551 \times 2{\cdot}54}{\sqrt[3]{907{\cdot}2}} = 5{\cdot}269$

$= \underline{\underline{5{\cdot}27}}$ say instead of 4·68

(iii.) $m = \dfrac{l}{\sqrt{a}} = \dfrac{52{\cdot}197}{\sqrt{814{\cdot}96}} = \underline{\underline{1{\cdot}83}}$ before.

N.B.—These new values are necessary, as Mr. Hargrave takes the weight for the Pteropus Edulis, with wings 20·551″ long, too much, where

$$a = (n\sqrt[3]{w})^2 \times l = r\sqrt[3]{w}.$$

APPENDIX B.

Calculation for a Flying Fox, as to size if it weighed 200 lbs., taking the corrected values of n, r, and m as given in Appendix A

We have

$l = r\sqrt[3]{w}$

$= 5{\cdot}27\sqrt{200 \times 453{\cdot}6}$ grammes

$= 5{\cdot}27\sqrt[3]{90720}$

$= 5{\cdot}27 \times 14{\cdot}63$ centimetres

$= \dfrac{5{\cdot}27 \times 14{\cdot}63}{2{\cdot}54}$ inches

$= 93{\cdot}22$ inches

$= 7\frac{3}{4}$ feet.

To find a (the area) we have

$$a = \frac{l^2}{m^2} = \frac{14{\cdot}63 \times 5{\cdot}27^2}{1{\cdot}83} \text{ sq. centimetres.}$$

$= \underline{\underline{18{\cdot}22}}$ square feet.

As each wing has to fly 100 lbs., there must be a supporting pressure of $\dfrac{100}{18{\cdot}22}$ lbs. per square foot of area $= 5{\cdot}49$ lbs., say $5\frac{1}{2}$ lbs.

APPENDIX C.

Clock spring model (See Fig. 4.)

The spring raised 1 lb. thro. $4\frac{1}{2}'$ in 3″,
therefore spring „ „ 90′ in 1′,
work = 90 ft. lbs. = ·002727 H.P.,
weight of spring = $6\frac{3}{4}$ oz.

Experiment—

Model weighing 1 lb.
Strokes, 2 per minute.

Result, model raised itself and travelled along a wire.

If the spring was stronger to give 3 strokes per second, it would give the same number as in nature.

To ascertain the strength for this,

$$\frac{v'}{v} = \frac{3}{2} \quad \frac{R}{R'} = \frac{v^2}{v'^2}$$

$$R^1 = \frac{9}{4} R,$$

therefore H.P. required $= \dfrac{9}{4} \times {\cdot}002727$

$= {\cdot}006136.$

From above, if ·006136 H.P. is enough to fly 1 lb., then 1 H.P. is sufficient to fly 162 lbs.

APPENDIX D.

Cultriss' motor for $4\frac{1}{2}'$ wings.

(i.) *To find the equivalent weight* for strain to be added to body of model when suspended at points of attachment of crank rods. (See Fig. 15.)

In this case

$$w = 10{\cdot}4 = P$$
$$w_3 = 2{\cdot}8$$
$$w_2 = 4{\cdot}8$$
$$\frac{p}{2}+\frac{p'}{2} = P' = P - \frac{18}{22}\times 2{\cdot}8 - \frac{2{\cdot}875}{22}\times 4{\cdot}8$$
$$= 10{\cdot}4 - 2{\cdot}3 - {\cdot}63 = 7{\cdot}4 \text{ lbs. say.}$$

If w_4=the weight for strain to be added, then

$$w_4 \times 2{\cdot}875 = P\,(22 - 2{\cdot}875),$$
$$w_4 = 7{\cdot}4 \times \frac{19{\cdot}125}{2{\cdot}875} = \underline{\underline{48{\cdot}8}} \text{ lbs.}$$

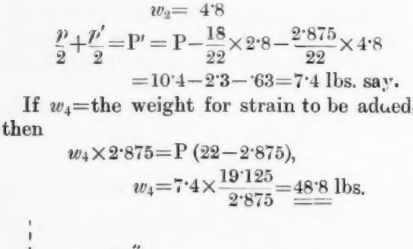


FIG. 15.

(ii.) *To find the amount of strain* on the springs. Let S=the total strain,

then $S \times {\cdot}75 = P' \times 22$

$$S = \frac{7{\cdot}4 \times 22}{{\cdot}75} = \underline{\underline{217}} \text{ lbs.,}$$

therefore the strain on each side $= \frac{217}{2}$

$$= \underline{\underline{108{\cdot}5}} \text{ lbs.}$$

(iii.) *To find the work* exerted to produce 96 strokes per minute of 30°.

The work is that required to raise (w_1+w_4) through a height of $1\frac{1}{2}''$ at 96 times per minute.

$$\text{work} = (7{\cdot}4 + 48{\cdot}8)\frac{1{\cdot}5}{12}\times 96$$
$$= 56{\cdot}2 \times 12 = 674{\cdot}4 \text{ ft lbs.}$$

therefore 674·4 ft. lbs. are required to work a model weighing 10·4-lbs. at 96 strokes per minute in imitation of nature.

(iv.) *Calculation for the extra work* necessary for flight.

The number of strokes to produce this is taken at 144 per minute.

The work increases with the resistance; this is with the square of the velocity,

therefore if w^1=work required,

$$w : w^1 = 96^2 : 144^2,$$

but $w = 674{\cdot}4$ ft. lbs.

$$\therefore\ w^1 = 674{\cdot}4 \times \frac{144^2}{96^2}$$
$$= 1742{\cdot}4 \text{ ft. lbs.,}$$

therefore 1742·4 ft. lbs. are required to fly 10·4 lbs.

(v.) *To find the rate of load per Horse Power.*

As 1742·4 ft. lbs. will fly 10·4 lbs.,

1 ft. lbs „ ·00596 lbs.,

therefore 1 H.P. = 33,000 ft. lbs. will fly $\underline{\underline{196{\cdot}68}}$ lbs.

APPENDIX E.

To calculate the power required for flight from experiments with a model weighing 3·4 lbs., having 2′ wings.

We find by experiment that when the model is weighted with 48 lbs. added to the body, the springs at $\frac{5}{8}''$ out are stretched ·18″ for each stroke of the wings at 144 strokes per minute.

The springs used on each side of the body stretch $\frac{1}{8}''$ respectively, with a load of 10 lbs,

therefore each stretches 1″ with 80 lbs.

„ „ ·18″ „ 14·4 lbs.

therefore the pair of springs stretch ·18″ with 2×14·4 lbs. equal to 28·8 lbs.

The work done each stroke is to raise 28·8 lbs. a height of ·18″ 144 times per minute

$$= 28{\cdot}8 \times \frac{{\cdot}18}{12}\times 144 = \underline{\underline{62{\cdot}2}} \text{ ft. lbs.}$$

As the amplitude should be 30° or more, instead of 17°, the work must be increased to suit for the extra resistance and rise required.

The resistance of the air to the stroke of the wing increases with the square of the velocity, so that if

R =the resistance of the air at velocity v,

R′=the resistance of the air at velocity v',

then $R : R' = v^2 : v'^2$.

As the amplitude is nearly doubled,

$v' = 2v$ say,

or $v : v' = 1 : 2$,

therefore $v^2 : v'^2 = 1 : 4$

„ $R : R' = 1 : 4$

$R' = 4R$.

Again, to compare the work if

w =the work for amplitude 17°

and w'= „ „ 34°,

then $w : w'$ as $1 \times R : 2R'$

as $1 \times 1 : 2 \times 4$,

therefore $w'=8\ w=8\times62\ 2$ ft. lbs.
$=497{\cdot}6$ ft. lbs.
$=\underline{\underline{500}}$ ft. lbs. say.

To calculate the rate of load per Horse Power, we have

500 ft. lbs. for 3·4 lbs,
therefore 1 ft. lb. for ·0068 lbs.
,, 33000 for 226·4 lbs.

NOTE.—The writer is indebted to Mr. O. Chanute, C.E., for checking and correcting the above calculation.

APPENDIX F.

Calculation for a direct acting electro-motor on arms fitted with ball bearings, with springs at $1\frac{1}{8}$" out, and strained with a dead load of 220 lbs. (See Fig. 13.)

The arms make 144 strokes per minute, with an amplitude of 26°.

(i.) *Work*$=220\times\frac{11}{16}\times\frac{1}{2}\times\frac{1}{12}\times144=\underline{\underline{907{\cdot}5}}$ ft. lbs.

(ii.) *To ascertain the weight* which this will fly, we have by the 2′ winged model that 1 H.P. will fly 226·4 lbs. (See Appendix E.)

Therefore if w=the weight required, we have by comparison

$$226{\cdot}4 : w = 33000 : 907{\cdot}5$$
$$w = 6{\cdot}2 \text{ lbs.},$$

therefore the 907·5 ft. lbs. will fly 6 lbs., say.

(iii.) *To find the length of wing*, we have by Mr. Hargrave's formula, as corrected (see Appendix A)—

$l=r\sqrt[3]{w}$ where $w=6\times453{\cdot}6$ grs.
$r=5{\cdot}27$

$$=\frac{5{\cdot}27}{2{\cdot}54}\sqrt[3]{6\times453{\cdot}6}=\frac{5{\cdot}27}{2{\cdot}54}\sqrt[3]{2721{\cdot}6}$$
$$=\underline{\underline{29}} \text{ inches.}$$

The centre of pressure is $\frac{4}{9}\ l$ out, and is therefore at $\frac{4}{9}$ of 29" out=13" out, say.

(iv.) *To find the load to be added* for strain we have

$$w_4\times\frac{11}{16}=\mathrm{P}'\times13,$$

where $\mathrm{P}'=\frac{4}{5}\times13{\cdot}5=10{\cdot}8$,

therefore $w_4=\frac{10{\cdot}8\times13\times16}{11}=\underline{\underline{204}}$ lbs.

(v.) *To find the area of the wings.*

As the wings are 29" long, we can find the area by the formula (see Appendix A)—

$$a=\frac{l^2}{m} \text{ where } m=1{\cdot}83$$
$$=\left(\frac{2{\cdot}5}{1{\cdot}83}\right)^2=1{\cdot}866,$$

therefore for the two wings, total area $=3\frac{3}{4}$ sq. ft.

(vi) *To find the load per square foot* of wing.

The load=6 lbs. for whole area,

therefore load per sq. foot$=\frac{6}{3{\cdot}75}=\underline{\underline{1{\cdot}6}}$ lbs.

The motor in this case is therefore powerful enough for a model weighing in all 6 lbs., with wings 29" long.

N.B.—As the motor itself weighs nearly $3\frac{1}{2}$ lbs., it is too heavy. One with better weight efficiency is necessary.

APPENDIX G.

Calculation for a tandem machine for 250 lbs.—the wings to fly $2\frac{1}{2}$ lbs. per square foot.

(i.) *The area* of each of the four wings must therefore=25 square feet.

(ii.) *To find l* we have by formula (Appendix A)—

$l^3=a\ m^2=25\times1{\cdot}83^2$
$l=9'\ 2''$.

(iii.) *To find the increase of pressure* due to the velocity of the tip of the wing compared with that of a Flying Fox with 20" wings:

$$v' : v' = 20^2 : 110^2$$
$$= 4 : 121 = 1 : \underline{\underline{30{\cdot}2}}.$$

(iv.) *To find the velocity of translation* as compared with a Flying Fox.

The pressure is 30·2 times greater, and therefore equals 30·2 lbs. compared with 1 lb.

By the formula for resistance of air we have

$$\mathrm{R}=\mathrm{A}\ \frac{v^2}{441},$$
$$\therefore v^2=441\times30{\cdot}2$$
$v=118{\cdot}4'$ per second
$=118$ miles per hour.

(v.) To find the velocity of tip of wing up and down.

$vel=9{\cdot}15\times144=1317'$ per minute
$=\underline{\underline{15}}$ miles per hour.

Calculation of strains and power for a 9′ 2″ winged tandem machine (see Fig. 14):

l=110 inches
w=125 for one pair of wings.
x=1 inch as this will allow a stretch of $\frac{1}{2}$ inch for the springs.

$\frac{p}{2}+\frac{p'}{2}=\frac{4}{5}\,w$ to admit of a deduction for the weight of the wings, springs, motor, &c., referred to the centre of pressure.

(*a*) Strain on springs=S (for total both sides):

$$S\,x=\left(\frac{p}{2}+\frac{p'}{2}\right)\frac{4}{9}\,l$$

$$S=100\times\frac{4}{9}\times110=4888{\cdot}8 \text{ lbs.},$$

therefore strain on each spring=2444·4 lbs.

(*b*) Let w_4=load to be added for each pair of wings

$$w_4\,x=\left(p-\frac{3}{4}\text{ wt. of wing}\right)\left(\frac{4}{9}\,l-x\right)$$

$$w_4=(125-10)\left(\frac{440}{9}-1\right)=115\times48$$

$$=5520 \text{ lbs.}$$

(*c*) *Work for flight* is to raise 5520 lbs + the weight of the body through $\frac{x}{2}$ 144 strokes per minute.

$$\therefore \text{ work}=(5520+80)\,\frac{x}{2}\times144\times\frac{1}{12}$$

$$=5600\times63=3600 \text{ ft. lbs.}$$

$$=1 \text{ H.P. say for one pair of wings,}$$

therefore work for two pairs of wings to fly 250 lbs. is a little over 2 H.P.

APPENDIX H.

Calculation to see whether work would be increased if the wings were made larger for the 250 lbs. load, than calculated for in Appendix G.

Load=250 lbs. for the two pairs of wings at $2\frac{1}{2}$ lbs. per sq. foot in Appendix G.

Taking the load at $1\frac{1}{4}$ lbs. per square foot instead, the area of each wing=50 sq. ft.

(i.) *To find l* we have (Appendix A)—

$$l^2=a\,m^2$$

$$=50\times1{\cdot}83^2$$

$$=12{\cdot}94'=12'\,11\tfrac{1}{4}''.$$

(ii.) *Increase of pressure* due to velocity of tip vertically compared with that of a Flying Fox with wings 20′ long.

$$v : v'=20^2 : 155{\cdot}28^2$$

$$=1 : 60.$$

(iii.) Calculation for the strain on springs, &c.—

$$\frac{p}{2}+\frac{p'}{2}=\frac{4}{5}\,w=100 \text{ lbs.}$$

(*a*) Strain on spring=S for both sides.

$$x=\left(\frac{p}{2}+\frac{p}{2}\right)\frac{4}{9}\,l$$

$$S=100\times\frac{4}{9}\times155{\cdot}28$$

$$=6900 \text{ lbs. say,}$$

therefore strain on each side=3450 lbs.

(*b*) Load to be added to body for strain $=w_4$ say, then

$$w_4\,x=(p-\tfrac{3}{4}\text{ wt of wing})\left(\frac{4}{9}\,l-x\right)$$

$$w_4=(125-10)\,(69-1)=115\times68$$

$$=7820 \text{ lbs.}$$

(*c*) Work for flight is that required to raise 7820 lbs.+weight of body through $\frac{x}{2}$ 144 times per minute

$$=(7820+80)\,\frac{x}{2}\times144\times\frac{1}{12}$$

$$=7900\times6=47400 \text{ ft. lbs.}$$

$$=1{\cdot}43 \text{ H.P.},$$

therefore for two pairs of wings work equals $2\times1{\cdot}43$ H.P.=2·86 H.P.

By comparison with the work required by the 9′ 2″ wings, see Appendix G; for the same load it may be seen that the larger wings require more power to work them.

APPENDIX I.

SLIPS FOR LAUNCHING MODELS.

The slips are ordinary electrical bell indicators fixed in suitable wooden frames. These frames are suspended from an overhead horizontal wire H as shown. (Fig 11.)

The frame A is fitted with a slip catch as shown. On closing the electric circuit from the electric battery on the ground, the electro magnet of the slip catch C frees the catch and lets the model M hanging from it go free.

The model M is suspended with a thread *p* to frame B, and swings off like a pendulum with the wings spread open.

The momentum acquired by the model in its swing can be increased by lengthening the drop and distance apart of the frames A and B.

The frame B is also fitted with the slip catch, in this case the frame is in a vertical instead of a horizontal position.

Two heavy weights are attached to the bottom of it to keep it steady and vertical. Two are necessary so as to leave a gap between them for the pendulum thread to swing between.

A slip bar *b* rests on the slip catch C to carry a pendulum wire P; at each end of this wire P is a loop, the upper for slipping on the bar *b*, and the other for attaching the thread for suspending the model.

A cross bar *d* of metal is passed into any of the holes *e* as required in the frame B below the slip catch. The position of this bar *d* adjusts the angle of inclination for the throw-off of the model M.

The cross bar *d* is connected with an elec-

trical wire to one pole of the battery. The pendulum wire P is in electrical circuit through the coils of the electro magnet of the slip catch to the other pole of the battery.

When the flying machine model M is slipped from the frame A, the pendulum wire P in the course of its swing comes into contact with the cross bar *d*, and makes electrical contact with it. The slip catch of the frame B then operates and frees the pendulum wire, and lets the model go free on to the air.

The thread and wire P fall clear of the model as they are attached with a hook. This hook turns over and clears itself automatically.

The cross bar *d* is tried in the different holes *e*, *e'*, *e''* . . . . till the longest throw for the model is obtained with the wings kept distended.

It has been found that an inclination of $\frac{1}{8}$ gives the best result.

Andrée's Polar Balloon Expedition.

What may, without doubt, be described as one of the most daring and venturesome of journeys ever undertaken has been entered upon by Herr Andree and his companions. The balloon containing the bold explorers left Spitzbergen on July 11th, at 2.30 p.m., the wind then blowing from the S.S.W. at about 20 miles an hour. Various accounts of the start have been given, but it appears that in the somewhat gusty and unsteady wind blowing, the balloon shot up to a height of 300 ft. and then fell nearly to the level of the water, over which it rapidly travelled. In this first bound two of the three guide-ropes became detached, but there was plenty of spare rope in the car, and, as the photographs taken show, there appeared to be quite a sufficiency of rope trailing behind to give the desired effect. It is said that the effect of his was at once apparent, for though the wind was from the S.S.W., the balloon travelled if anything to the west of due north. It is in the action of these guide-ropes and sails that we must feel special interest, for should the voyage be happily successful, the general public will undoubtedly hail this as an invention solving the problem of aerial navigation! Such sentiments, indeed, we have already seen in print, but, of course, it is almost superfluous to point out that this system of balloon guiding is only applicable to the arctic regions or other wide uninhabited districts, where no damage could be done by the trailing ropes, which so limits the employment of a balloon thus fitted, that we doubt if equipments of this sort will often be used, however successful Herr Andree may be.

The only news we have at present of the expedition is that contained in the two pigeon messages, which were despatched within two days of the start, and give very little information beyond the fact that all was well. The balloon must by now be exhausted of sufficient gas to carry the aeronauts, but we will hope they are safe in some place whence they will be able to reach, on foot, some inhabited locality. It would be interesting to know what Herr Andree decided was to be done with the balloon when no longer capable of bearing its crew; but it is possible that after being relieved of the stores, and two of the aeronauts, the third might endeavour to travel further, and if he reached civilization first, report the whereabouts of the others. Or finally the balloon could be sent up by itself with despatches. But if either of these courses had been adopted, we should hope to have heard something definitely by this.

New Suggestions for Aerial Exploration.

Herr Andree's venturesome voyage having called attention to the great advantages of the aerial highway as a means of reaching the Pole, and other places difficult of access, several ideas have lately been brought forward for more efficiently utilizing this route through the air.

One of them originated, or is supposed to have originated, with Mr. Edgar Wilson, who proposes using a balloon, the temperature of the gas in which is controlled by a lamp. The descriptions he has published accord remarkably with a proposition illustrated in the Journal of the Royal United Service Institution for June, 1883. But it is very doubtful if much advantage is to be gained from this method, even if it practically answered. The upper currents of the air are too variable to be depended on for reaching any given destination. Mr. H. A. Hazen, of Washington, D.C., has suggested that in further attempts to reach the Pole or to cross the Atlantic by balloon, advantage should be taken of the fact that at heights over 6,000 feet, the winds are

thrice stronger than they are at the surface of the earth. At this height there would also be less danger from moisture freezing on the balloon. The longest balloon journey on record, that in 1859, from St. Louis, Mo., to Henderson, N.Y., a distance of 870 miles, was covered in 19 hours, at a height of 7,000 ft.

Whilst the subject is before the public, I may mention an idea that has occurred to me, though I have not yet been able to obtain sufficient data to be sure of its practicability. Let it be granted that the scheme adopted by Andree is good enough, except for the one important point that his gas will after a time give out. I would then suggest substituting a kite or series of kites for the balloon. The facts that we have to go upon are: That a kite can be constructed which will float in the lightest of winds. That a kite can be made large enough, or a sufficient number of kites be attached together, to lift a man. That if the string of a kite be attached to a moving object, such as a boat or cart, it will tow the same along, and remain flying in the air. Also (for I have recently tried the experiment) that this object may be a simple heavy rope. It would therefore appear not impossible to use a kite or series of kites instead of a balloon with trail ropes.

There is practically no limit to the amount of kite power which could be employed. We know that about 500 sq. ft. of canvas is sufficient to raise a man in an average wind. But there is no reason why, for such a purpose as is here proposed, we should not employ 5,000 or 50,000 sq. ft.

These kites then would support a car containing the men, stores, etc., and a heavy trail rope, or better, several ropes, would be drawn over the ice and water below. Steerage way could be obtained, probably with much more efficiency, after the manner used by Andree. The only condition to fear would be a lack of wind, but when this occurs it merely implies a halt, which would also practically be the case with a balloon.

It has been ascertained that, as a rule, the wind increases in velocity the higher we go, and that at 1600 feet up the rate is double that at 100 feet. As the leading kite could easily be maintained at the former altitude or higher, the kite apparatus should be able, as a rule, to travel faster than a balloon with guide ropes.

The kite would also possess the following advantages: No danger from fire, so that a stove could be more comfortably used. In case of accident, the poles and material of the kites could be converted into sledges or boats. The apparatus would be much less costly, and therefore, if crews could be formed (as they undoubtedly could), several expeditions could start at the same time, which could render one another mutual aid.

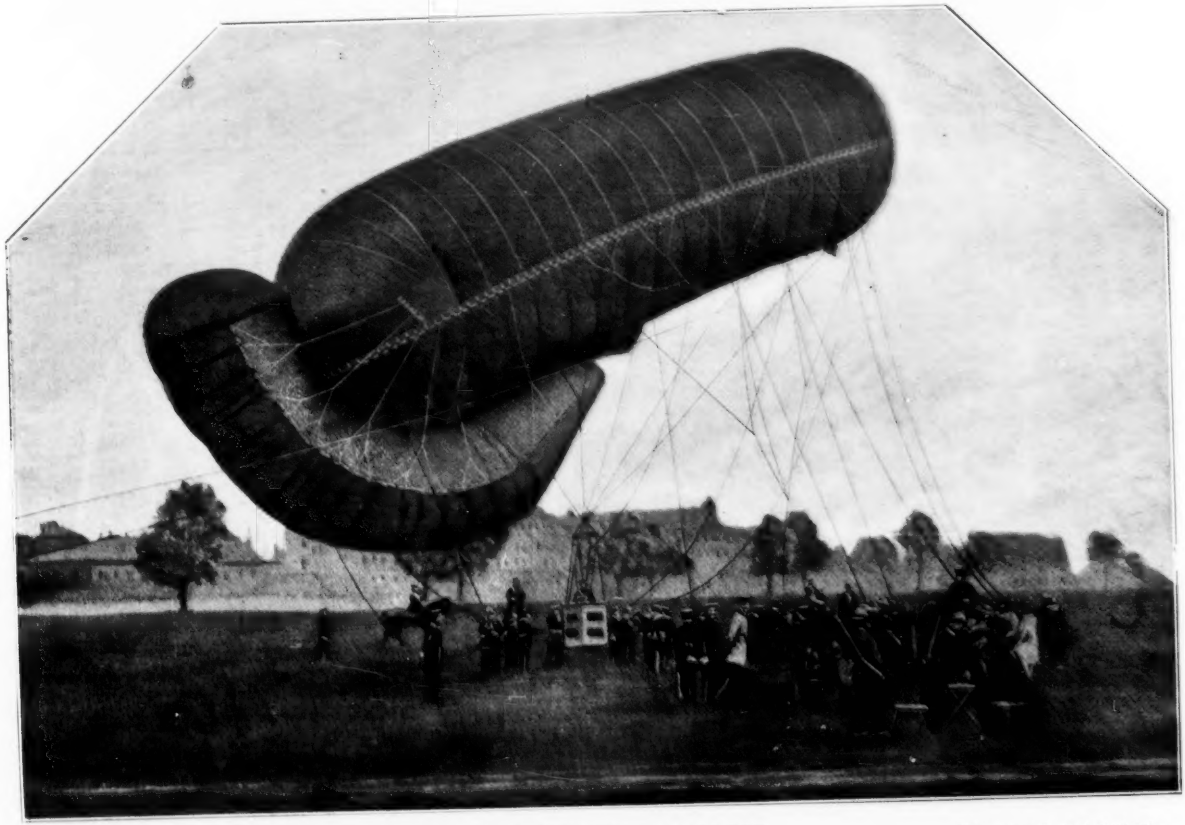
Then again, in the event of a calm region existing around the Pole, as has been suggested by some authorities, the kites if carried into it by some abnormal wind, could be packed and transported over the ice back to the windy districts, an operation impossible with a large balloon.

Altogether then, I see no reason why a kite-car with trail ropes should not be used in preference to a gas balloon.

B. BADEN-POWELL.

The New German War Balloon.

For some time past we have had more or less meagre accounts of the so-called kite-balloon on trial in the German army, the patent for which was referred to in our April journal, but now we are able to reproduce a photograph which gives a very good idea of its general appearance. The principal intention is not only to have an elongated balloon, whose end presents less resistance to the wind than the side of a spherical one, but to so slope it that its under side acts on the principle of the kite. In order, moreover, to keep the balloon tightly distended, so as to preserve its shape, a reservoir with a funnel-shaped mouth is added, into which the wind blows and keeps the whole apparatus firmly distended; the stronger it blows, the greater will be the internal pressure in this pocket. A kind of rudder-like attachment, consisting of a smaller balloon, is fixed behind, so as to keep the whole steadily facing the wind, while another auxiliary balloon is sometimes applied to retain the position. The volume of the main balloon is about 18,000 c. ft. When floating in the air its axis forms an angle of some 50 degs. with the horizon. This invention, which is the device of Capt. Parseval, of the German army, is said to most successfully fulfil its object, viz., remaining steady in strong and gusty winds. To anyone familiar with our own war balloons, however, this apparatus, with its numerous ropes and other attachments, appears most complicated and unwieldy. A balloon of this description is also said to have been tried for naval purposes at Kiel.



THE GERMAN WAR BALLOON.

From the *English Mechanic*.

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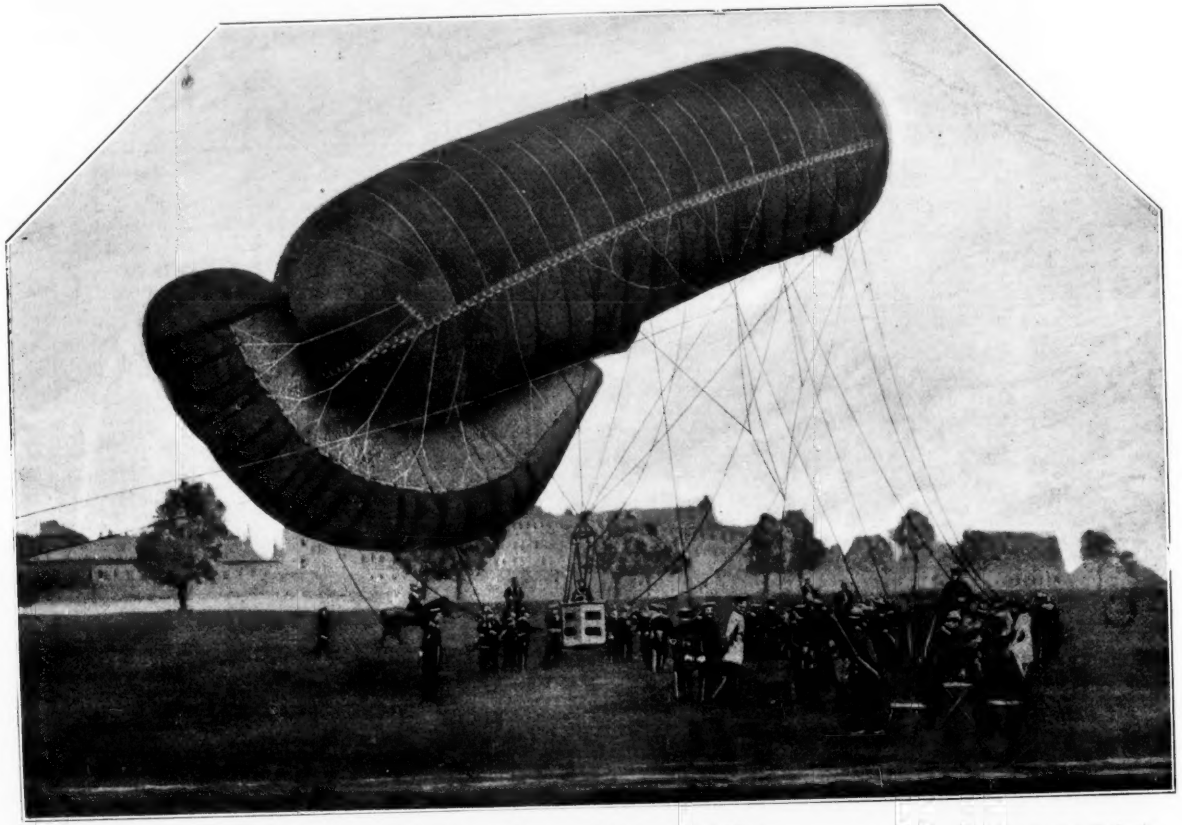


THE GERMAN WAR BALLOON.

From the *English Mechanic*.

NOTES.

DAVIDSON'S "VOLATION" FUND.—Mr. George L. O. Davidson has written letters to several of the leading papers on "The Supremacy of the Air. Is Great Britain to have it?" He very clearly and concisely points out how aerial navigation may now be considered as entering upon the range of practical politics, and indicates the possible danger which might accrue, should any other nation discover how to construct practical flying machines. He therefore suggests the creation of a "Volation" Fund for the purpose of investigating the subject; and has more recently written to say that in response to this communication he has received promises of support to the amount of £700 "for experimenting in the direction indicated under the advice of experts." Mr. Davidson is to be congratulated on his endeavours to stimulate the progress of invention in aeronautics, but we shall be anxious to see in what manner the funds are to be expended.

A LIFE-SAVING KITE.—Capt. F. Spiers, a retired master mariner, has perfected a good kite apparatus for life-saving at sea. The kite consists of a simple oblong of oiled canvas stretched on a frame of two cross sticks. An ingenious drum, or system of several drums, is arranged to pay out the kite string followed by the life-saving hawser. Capt. Spiers has a working model, which he is prepared to show to anyone interested in this subject. And it is to be hoped that this humane invention will speedily be adopted.

STEAM FLYING MODEL.—At the sitting of the French Academy of Sciences, on July 5, M. Marey read a paper forwarded by M. Tatin, a noted aeronaut and engineer, and Dr. Richet, editor of the "Revue Scientifique," on steam aerodromes. Experiments with these machines are being carried on in emulation of those undertaken by Mr. Langley, the eminent secretary of the Smithsonian Institute, 10 months ago, in Potomac Bay, near Washington. The French experiments have been made at Carquenez, near Toulon. The aerodrome weighed about 70 lbs., or two and a half times as much as the American one. The power of the engine was about the same, a little more than 1 h.p. The French machine had two screws instead of The French machine had two screws, one in front and the other behind. The maximum velocity obtained by MM. Tatin and Richet was greater—namely, 18 metres (19.692 yards) per second instead of 10—but the length of their run was only 140 metres (153.16 yards), instead of more than a kilometre (1093.6 yards). The duration of the experiment was likewise only a few seconds, instead of more than two minutes. The French aerodrome had merely two lateral projections and a tail. The total breadth of the aerodrome was a little more than six metres, and the surface a little more than eight square metres.—"Invention."

THE DANGERS OF FLYING MACHINES.—The "World," in an article on human flight, falls into a widely-believed fallacy. It says, "If any statistician of a morbid turn of mind were to occupy himself in tabulating the catastrophes which have resulted from ill-starred attempts to grapple with the problem, within say, the last half century, the 'butcher's bill' which he would have to present would surely total up to a figure formidable enough to give pause to the most inveterate optimist on the subject." Without being in much of a "morbid turn of mind" we have carefully noted all such catastrophes. Putting aside ordinary balloon accidents, where no special desire to further the progress of the navigation of the air was involved, we can only remember four actual fatalities, De Groof, Lilienthal, Dr. Wolfert and his companion. Even serious accidents not incurring loss of life have been fortunately exceedingly rare. The same writer is evidently getting very far out of his element when he goes on to say "For all the sacrifice of life and labour, it has yet to be shown that we are any nearer to a controllable and reasonably safe method of air travelling than we were at the outset." Let him read up his subject before dashing into print!

WAELDE'S AERIAL PROPELLER.—We recently had an opportunity of witnessing a trial of this invention. The apparatus consists of what may be described as a pair of feathering paddle wheels, though each wheel is fitted with only three "floats," these consisting of a circular frame $3\frac{1}{2}$ ft. in diameter, covered with cloth, pivoted on trunnions. These paddles are actuated by man power by means of endless chains, two men working pedals similar to those of a bicycle. The angles at which the blades strike the air are controlled also by endless chains, so that by means of a pair of levers the propellers can be made to thrust up or down, forwards or backwards. The present apparatus, which is but a large working model, is neatly constructed of steel tubing weighing about 115 lbs. It is suspended from one end of a beam, the other end bearing a counterpoise. In this way a good idea of its action may be obtained, though its exact power has yet to be determined. Mr. Waelde states that one man

can by this means lift 25 lbs., which though but a small portion of the total weight to be lifted, would be useful if the apparatus were suspended beneath a balloon. As for the amount of lift to be obtained when a suitable motor is applied, nothing is yet known, but the principle is undoubtedly capable of further development. Further details are given under heading of "Patents" (No 9108).

LAMSON'S MAN-LIFTING KITE.—Mr. C. H. Lamson, of Portland, U.S.A., has now succeeded in raising a man with his kite. This machine is somewhat on the principle of that of Hargrave. According to Mr. Lamson's description of his kite, it consists of four pairs of wing-like sails, ribbed fore and aft, and superposed in pairs, with vertical webs or keels at the end of each pair to prevent lateral swaying and to increase the stability of the machine. The spread of the wings is twenty-six feet, and the framework, including the bowsprit, is about the same. The frame is constructed of American spruce, as this wood is said to be the toughest and lightest of any found about here. The sail fabric is of woven Berckley cambric, and the sails spread out on each side of the kite like the wings of a bird. The kite weighs about a hundred pounds, and the rider sits in a boat-shaped car, which is suspended from between the two sets of box kites. Attached to the bottom of this car are two bicycle wheels, by means of which the kite can be moved along the ground without danger of breaking the structure. The sails are so placed that when the supporting surfaces are folded down the kite may be moved about by one man.

FOREIGN AIR SHIPS.—It is said that there are now three experimental machines being completed in Russia. At St. Petersburg, M. Okramovitch is constructing an aeroplane; at Kharkoff, Doctor Danilevski has a flying machine which is reported to be an object of astonishment to all the savants who have examined it; and M. Tchernouchenko also has an aerial vessel, which he hopes to try shortly. In Austria, Professor Schwartzmann is finishing a flying machine. In Germany, Herr Grussmann has a new airship and M. Fuvie, in France, is going to try a navigable balloon.

WHO FIRST SUGGESTED ARCTIC EXPLORATION BY BALLOON?—This is a question which has received some attention of late, but probably no one person can exactly claim the honour. When first balloons were invented, many writers pointed out that they might be of use for geographical exploration. When Green, more than sixty years ago, invented the guide-rope, such sentiments were reiterated. In 1876, Mr. C. Spencer sent to the papers a description of a balloon fitted for polar exploration, and in the same year Mr. Coxwell elaborated a scheme for Commander Cheyne, which would probably have been carried out, had sufficient funds been forthcoming. Indeed, this project gave rise to so much discussion that it may be said to have led to the various proposals since made. A Mr. Hutchins now claims to be one of the originators of the idea, having written an article on this subject in 1879.

RUSSIAN AERONAUTICAL EXHIBITION.—It is proposed to hold an international exhibition of aeronautical apparatus in the summer of 1898 in St. Petersburg. The organizers are MM. Raukfuss and Knopp.

Recent Publications.

"*The Mechanics and Equilibrium of Kites*," by C. F. Marvin (Washington, U.S.A.). A monograph submitted in competition for the "Chanute Prize" offered by the Boston Aeronautical Society.

But a year ago it might be said that no scientific work on kites existed, yet in each of the four numbers of this journal we have had the pleasure of chronicling a new publication on this subject. The work now before us is indeed, from a scientific and theoretical point of view, quite the most exhaustive contribution. Professor Marvin goes deeply and thoroughly into his work, and carefully discusses the various effects of the wind pressures under all circumstances, the principal chapter being on "The Forces Acting on Kites," "Circumstances of Equilibrium," "Explanation of Flight of Kites," "Abnormal Flight of Kites," "Effects of Changes of Wind," "Condition of Stability and Steadiness," and "The Mechanics of the Kite String." But in this subject it is specially difficult to apply theory to practice. For instance, in this work, the author having elaborately discussed the position of the centre of pressure on a rectangular flat surface, owns that, "for the complex and multiple flat and arched surfaces usually found in kites, the position of the central axis cannot be located."

"*Meteorological Investigations in the Free Air*," by A. Lawrence Rotch, Director of the Blue Hill Observatory, Milton, Massachusetts, is a reprint of a paper read before the Boston Society of Civil Engineers in May last. After briefly recounting what has been done with balloons, an account is given of the cloud

measurements at Blue Hill, and details of the kite apparatus used at that establishment.

"*The Story of the Earth's Atmosphere*," by Douglas Archibald. (London: George Newnes.)

This handy little volume forms a most concise and succinct compendium of the Science of Meteorology in a popular form. Indeed it does more, for the chapter on "Suspension and Flight in the Atmosphere" is the one in which we are specially interested. A brief but comprehensive history of the balloon is followed by a short account of attempts to navigate the air, and a longer and illustrated description of kites and their uses. Though we notice one or two slight inaccuracies, such as the statement that Pilatre de Rozier in 1783 employed "ordinary coal gas" for his first ascent, we can thoroughly recommend this "nutshell full" of information to those who want to know about the atmosphere.

Foreign Aeronautical Periodicals.

L'Aéronaute (Paris), July: "The Destruction of Wolfert's Dirigible Balloon." (Full illustrated account.)

August: "The Aeroplane of Messrs. Tatin and Richet—from the Comptes Rendue and the Revue Scientifique."

September: "A Comparative Study of the Aeroplanes of Professor Langley and of Messrs. Tatin and Richet;" "Hargrave's Cellular Kites" (as in *Aeronautical Journal* for April).

La France Aérienne (Paris), 1—15 July: "Carelli's Dirigible Balloon." 15—31 July: "Air Ship, consisting of Two Elongated Balloons placed Side by Side, by M. Cruchet, and Criticisms Thereon, by M. Jobert;" "The Working of Captive Balloons," by Ch. Labrousse; "Recollections of the Siege of Paris" (continued).

1—15 August: "To the Pole by Balloon;" "Carelli's Dirigible Balloon;" "Balloon Ascents on the 14th July." 15—31 August: "Angelot's Paddle Wheel, and its Application to Aerial Navigation."

1—15 September: "Motors for Balloons;" "An Aerial Voyage;" "Siege of Paris" (continued).

Zeitschrift fur Luftschiffahrt (Berlin). May—June (the last received): "The Simultaneous Scientific Balloon Ascents of 14th November, 1896—Full Account of the Results;" "The Latest Experiments with Flying Machines," by Lieut. Hildebrandt; Illustrated Accounts of the Apparatus of Phillips, Wellner, Maxim, Stentzel, and Others; "Experiments with Large Aerial Screws," by G. Wellner, Records of Careful Experiments; "The 'Sporting' Balloon Ascent in Berlin."

Illustirte Mittheilungen des Oberrheinischen Vereins (Strasburg). The first number of the new publication of the lately-founded Upper Rhine Aeronautical Society. The first article is on the late Dr. Wolfert, with a photograph of his balloon. "Foldable Kites for Gliding Flight or Flying on a String" (illustrated); "Carrier Pigeons and their Use in Balloon Journeys" (illustrated); "Trials with Kites for Meteorological Purposes at Strasburg;" "Letters from Italy;" "American Experiments with Kites;" "Stentzel's Wing Machine" (illustrated).

L'Aeronauta (Milan), August—September: "Langley's Aerodrome;" "Italian Aeronautical Society;" "The Future of the Kite," an account of what has been done in England, America, and elsewhere; "Kite Balloon;" "The Theory of Aerial Navigation;" "Andrée's Expedition;" "Bird Flight;" Index to Vol. I.

Notable Articles.

July 2. *Mechanical World.*—"Aviation." Abstract of lecture by Mr. O. CHANUTE.

2. *English Mechanic.*—"Aerial Flight." F. H. WENHAM. Interesting article.

3. *Golden Penny.*—"About Flying Machines." 2nd Art. (Illustrated.)

10. *Saturday Review.*—"Flying Machines Next Century." G. L. DAVIDSON.

11. *New York Journal.*—"A Tale of a Kite." (Illustrated.) Lamson's Man-lifting Kite.

16. *Mechanical World.* "Aviation." Flight as effected by wind.

23. *English Mechanic.*—"Parseval's Kite Balloon." (Illustrated.)

23. *English Mechanic.*—"Aerial Flight." 3 letters.

24. *Saturday Review.*—"Flying Machines." Letter from Capt. BADEN POWELL.

24. *Invention.*—"Asbestos Balloons."

27. *Daily Graphic.*—"Herr Andrée's Expedition." (Illustrated.) General account.

30. *La Science Française.*—"La Roue Angelot." (Illustrated.) Description of invention for propelling balloons.

31. *Illustrated London News*—"Dr. Andrée's Balloon Voyage." (5 illustrations.)

Aug. *Knowledge.*—"Wind as an Aid to Flight." F. W. HEADLEY, M.A.

6. *English Mechanic.*—"The Aerial Problem."

7. *Black and White.* "The Andrée Balloon Expedition." Illustrated with a series of photographs.

12. *Nature.*—"Soaring Flights." (Illustrated.) Account of Mr. Pilcher's recent experiments.

19. *World.*—"Flights of Fancy."

21. *Saturday Review.*—"Has Andrée Found the Pole?" Capt. BADEN POWELL.

28. *Daheim* (Leipzig).—"Military Balloons."

Morning Post, Daily News, and other papers have letters from Mr. G. L. O. DAVIDSON on "The Supremacy of the Air."

Sept. *Knowledge.*—"Wind as an Aid to Flight." J. H. MOXLEY.

Gentlemen's Magazine.—"Balloon and Kite in Meteorology." A. MAC IVOR.

3. *English Mechanic.*—"The Aerial Problem."

3. *English Mechanic.*—"A Method of Controlling the Temperature of a Balloon. (Illustrated.) E. E. WILSON.

4. *Glasgow Herald.*—"The Navigation of the Air: I." First of a series of interesting articles on the present state of the science.

9. *Saturday Review.*—"The Art of Flying." Letter from Mr. E. S. BRUCE.

11. *Golden Penny.*—"The Growth of the Balloon." (Illustrated.) Popular *resumé* of the history of Aeronautics.

11. *Science Siftings.*—"Andrée, Where is He?" (Illustrated.)

11. *Glasgow Herald.*—"The Navigation of the Air: II." Chiefly accounts of recent trials and experiments.

18. *Glasgow Herald.*—"The Navigation of the Air: III." Theory of aeroplanes and air curves.

18. *Golden Penny.*—"The Conquest of the Air."

24. *English Mechanic.*—"The Aerial Problem," "Controlling Balloons," &c.

25. *Glasgow Herald.*—"The Navigation of the Air: IV." Experiments in gliding, and conclusion.

28. *Western Morning News.* "Herr Andrée and Ballooning."

Applications for Patents.

15,987. July 5. ALEXANDER ADAMS, Sydney, N.S.W. **A Compressed Air Reciprocating Force Machine Designed to Assist in Producing the Up and Down Beating Motions of the Wings, or Carrying Surfaces of Machines Designed for Artificial Flight.**

18,663. August 12. ROBERT KRAUSS, Karlsruhe, Germany. **A Controllable Means of Aerial Transport as a Public Amusement.**

18,935. August 16. GEORGE HARDACRE, 322, High Holborn, London. **An Improved Flying Machine.**

18,992. August 17. WILLIAM BENNETT RULE, Montpelier Square, London. **Land, Marine, or Aerial Locomotive Engines.**

19,301. August 20. HENRY SHIPLEY BOOTH, 6, Bank Street, Manchester. **Improvements in Aerial Machines.**

20,434. September 6. CARL HOLLE, 22, Bloomfield Road, Bow, London. **Improvements in Aerostatic Vessels.**

20,909. September 11. WALTER THOMPSON and JAMES LYLE, 73, Basinghall Street, London. **Improvements in Inflating and Deflating Balloons or Kindred Air Vessels.**

21,308. September 17. ARTHUR ALEXANDER GOVAN, Dunvegan, Bridge of Allan, N.B. **Control and Propulsion of Air Ships.**

21,355. September 17. ALFRED GEORGE BROOKES. (PETER IRGENS BAGGE, Norway.) **Improvements in Balloon Steering Apparatus.**

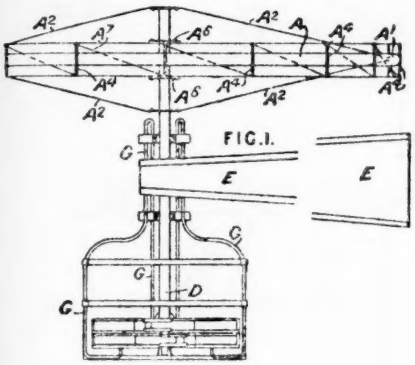
Patents Published.

From the *Illustrated Official Journal.*

3657. **February 18, 1896. Aerial Machines.** ROOTS, J., 100, Westminster Bridge Road, London.

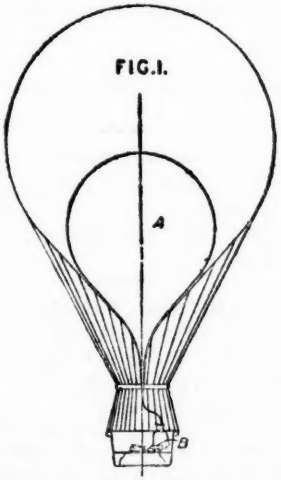
The machine is raised by a fan H on a tubular vertical shaft D driven by a motor, preferably an oil engine, carried in the car. A vane E prevents the car from being turned with the

fan, and a horizontal vane may control the inclination of the axis of the machine. Horizontal propulsion is effected by shifting the ballast so as to tilt the machine. The fan is composed of a tubular rim A1, braced by spokes A2, and with additional radial wires running from both ends of the rods A4 to the



flanges A6; sails A7 are laced to these wires so as to set at an angle of about 20degs. The motor is cooled by the blast from the fan or by water carried in the tubular framework G. The fan acts as a parachute when not in motion.

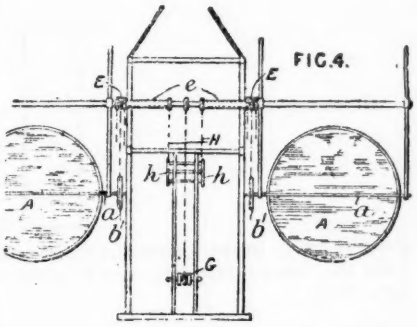
5129. March 7. 1896. Aerial Machines. Scott, R., 168, Croydon Road, Newcastle-on-Tyne.



The attitude is regulated by varying the buoyancy of the aerostat. This is made to withstand a considerable bursting pressure and contains a flexible vessel A, which can be inflated with air by a pump B in the car when it is desired to descend.

9108. April 30, 1896. Aerial Machines. Waelde, J., 24, Broad Street, Golden Square, London, and Abelspies, J. F. C., 18, Tyndale Place, Islington.

The propelling apparatus comprises a pair of paddle wheels, the blades A of which are feathered by a chain passing round a pulley *b*1, on their axle *a* and E on the sleeve *e* respectively. The feathering, and consequently the

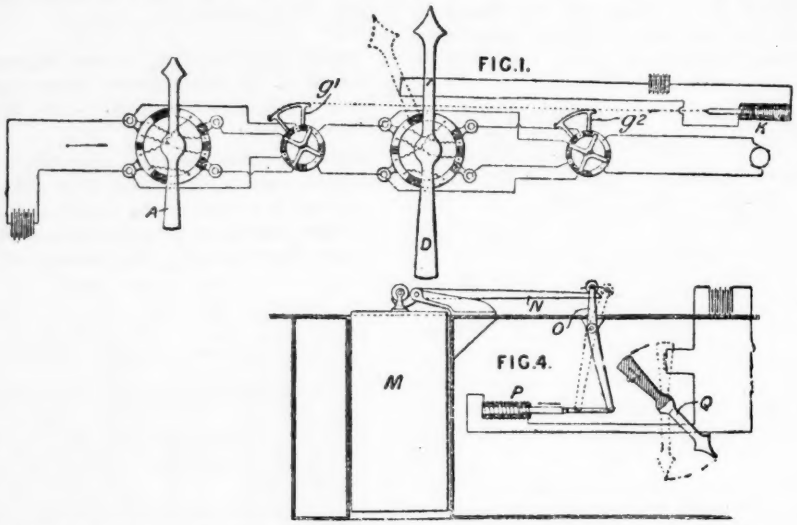


direction in which the blades make their effective stroke, is altered by turning the sleeve by means of a chain H and a lever working over a disc *h*. The apparatus is driven by pedals G, and may be attached to a balloon or used as above.

9142. April 30, 1896. Aerial Machines. Pennington, E. J., Racine, Wisconsin, U.S.A.

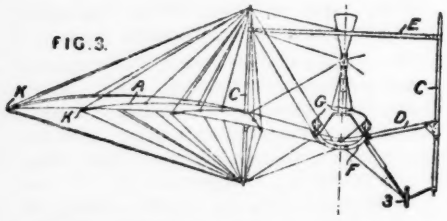
The invention is for automatically steering aerial machines and directing them towards large masses of iron, such as ironclad ships, and for automatic means for releasing bombs when immediately over such ships. Two magnetic compasses A, D are used which control, by electric means, the steering gear. A steers normally, and when the machine approaches an ironclad the needle D is deflected and completes an electric circuit through the coil K, by which the coil is drawn in, and the commutators *g*1, *g*2 are actuated for throwing the compass A out of, and D into, the steering circuit. D then takes up the steering, and directs the machine towards the ironclad. The bomb M, Fig. 4, is supported by a lever N, and released by the electro-magnet

P, which withdraws the lever O. The current for exciting the magnet P is completed by a dipping needle Q, when it assumes a vertical position owing to the presence of an ironclad below it. The releasing lever may be actuated by a clock.



9144. April 30, 1896. **Aerial Machines.** PILCHER, P. S., Artillery Mansions, Victoria Street, London.

The machine may be used without a motor for soaring, or with a motor and propeller for flying. It comprises a tubular framework F with handles G, and of just sufficient capacity to accommodate the aeronaut. On either side are carried masts C supported by rigid stays D,E, and from which radiate the ribs K of the wings A; these are stayed to the top and bottom of the masts. The wings have sleeves for the reception of the ribs, and are suitably lashed to their outer ends; they can be furled round the mast. Wheels 3, mounted so as to yield in a vertical direction, deaden the shock on landing. There is a horizontal rudder of about one-tenth the area of the wings, and steering is effected by the aeronaut altering his position in the car.



United States Patents.

586,590. July 20. **Air Car.** ADOLPH BRODBECK, Chicago.

Aerial Railway. Conical pointed balloon attached to rail.

588,556. August 24. **Air Ship.** THOMAS M. CREPAR, Grand Rapids, Minn.

Balloon with aeroplane round it, and "rocking" aeroplane.

589,373. **Traveller for Kite Strings.** ELMAR FOLSOM and EUGENE PACKARD. (Renewed.)

French Patents.

266,527. May 1. FRICKE. **Dirigible Aerostat.**

266,928. May 14. PAUBLAN. **Dirigible Balloon.**

German Patents.

APPLICATIONS.

P 7875. E. J. PENNINGTON, U.S.A. **Air Ship.**

P 8285. E. J. PENNINGTON, U.S.A. **Balloon or Flying Machine.**

Published by the Aeronautical Society.

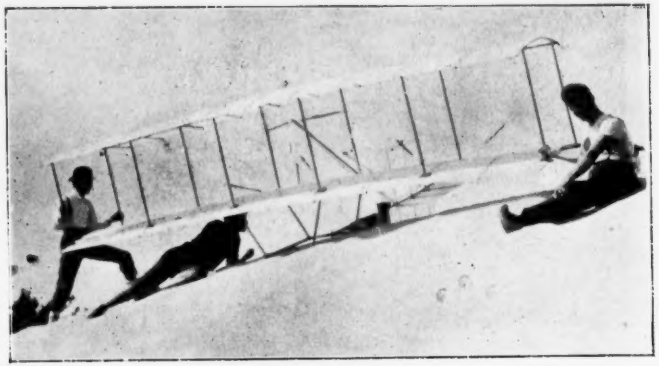
"THE NAVIGATION OF THE AIR."

BY ALEX. McCALLUM.

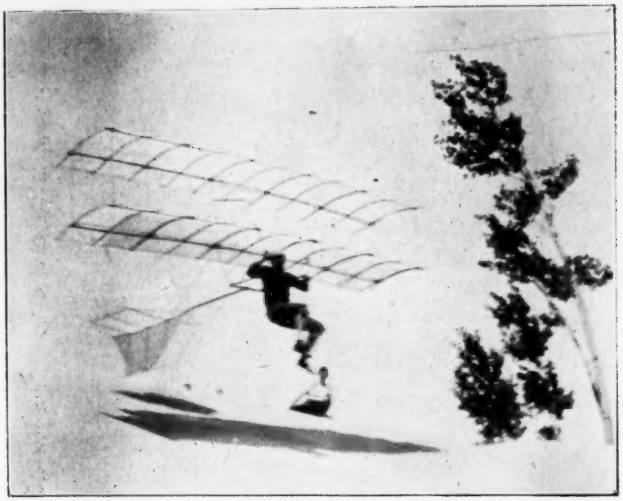
Reprint from the *Glasgow Herald*.

PRICE (to non-members), 6d. [In the Press.

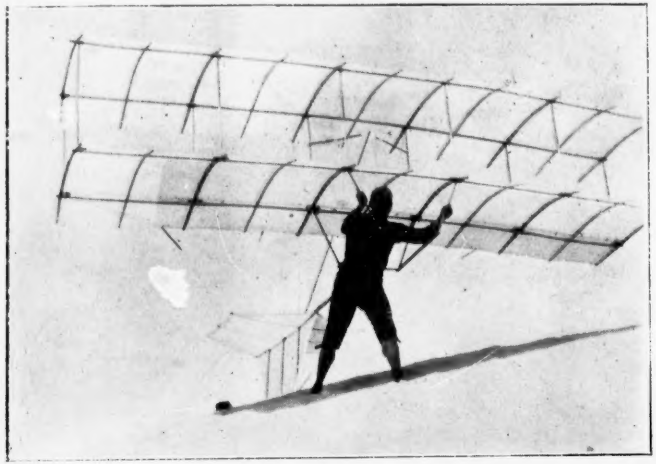
CHANUTE'S GLIDING MACHINE.



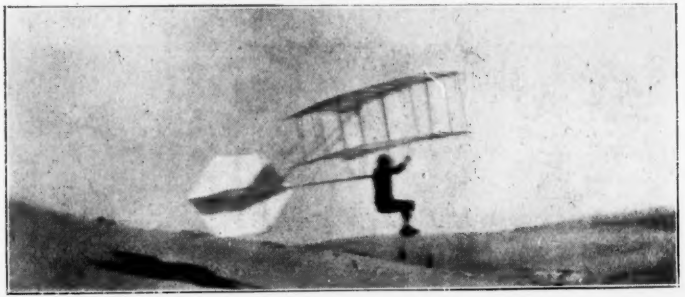
I.—GETTING READY.



III.—OFF.



II.—POISED.



IV.—STOPPING.

II.—POISED.

IV.—STOPPING.